Research Note

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THE EFFECTS OF INTRASPECIFIC COMPETITION WITHIN MOUNTAIN PINE BEETLE BROODS UNDER LABORATORY CONDITIONS

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INTRODUCTION

Studies of the population dynamics of the mountain pine beetle (*Dendroctonus monticolae* Hopk.) in lodgepole pine were begun in 1960. Part of these studies were designed, in effect, to biologically dissect a mountain pine beetle population to determine and evaluate factors operating to reduce or increase populations. The first factor chosen for laboratory study was intraspecific competition. This paper reports a laboratory experiment designed to determine the effect of competition under controlled conditions.

Competition would appear to be a primary factor in brood reduction, yet very few controlled experiments have been done to assess its role in population dynamics. McMullen and Atkins (1961)[1] studied the effects of competition in Douglas-fir beetle (*D. pseudotsugae* Hopk.) under caged conditions in the field. Reid (1956, 1957, 1958)[2] has noted mortality due to competition, both between and within galleries in his field studies on the biology of the mountain pine beetle.

1/ McMullen, L. H., and Atkins, N. D. Intraspecific competition as a factor in natural control of the Douglas-fir beetle. Forest Sci. 7: 197-203. 1961.

2/ Reid, R. W. Studies on the biology of the mountain pine beetle, *Dendroctonus monticolae* Hopk. Interim reports 1955-1, 1956-4, and 1957-4, Forest Biology Laboratory, Calgary, Alberta.

METHODS

Three lodgepole pine billets, 1 foot long by 36 inches in circumference were used as the food supply. Each billet was divided into thirds vertically by driving a line of corrugated fasteners through the bark, projecting slightly into the xylem. This gave three 1-square-foot areas of bark surface per billet and prevented larvae from leaving their segment of log. Attack densities of 3, 9, and 18 per square foot were chosen, based on the study plot data, to introduce three levels or population densities. These attack densities were the minimum, average, and maximum that had been recorded in the field. Each log then was a replicate containing each of the attack densities.

Newly emerging adults were collected from brood logs. All mites were removed from these adults, thus excluding their influence on brood reduction. The adults were then sexed and forced to attack at the prescribed densities in a purely random manner. Each feeding area of the logs was assigned a number series; i.e., log 1, 3-attack density area was designated 13; log 2, 9-attack density was 29; and so forth. Each attack per feeding area was made in the order of occurrence of the area code number within Tippett's table of random numbers. Thus if five pairs of beetles were obtained in one day they were distributed among three categories on three logs according to the random numbers. This was an attempt to simulate the attack progression as it might occur in the forest. Points of attack were spaced so that all pairs of attacking adults would have equal areas in which to construct egg galleries, and larvae per egg gallery would have equal feed areas within each density class.

Each feeding area was caged separately, using Saran screen. Each screen cage funneled to a vial so that the new adults could be removed and recorded as they emerged.

After all adults had emerged the cages were removed, the logs debarked, and the following data recorded for each feeding area: (1) length of egg gallery, (2) number of larval galleries originating from the egg gallery, (3) number of pupal chambers, and (4) number of emerging adults, including callow adults, found within the pupal chambers.

The data were subjected to analyses of variance between and within replicates by varying attack densities. Analyses were made for each of the stages: inches of galleries, larval galleries, pupal chambers, and new adults. Replicates differed significantly for only two stages (larval galleries and inches of egg galleries) and then at a low 75-percent confidence level. In all stages the data by attack density differed significantly at the 99-percent confidence level. Table 1 summarizes the mean data for each attack density.

Table 1.--Mean, standard errors of mean, coefficients of variation of the study population by stages, by attack densities

Stage	3: $\bar{X}$	3: $SE_{\bar{X}}$	3: CV	9: $\bar{X}$	9: $SE_{\bar{X}}$	9: CV	18: $\bar{X}$	18: $SE_{\bar{X}}$	18: CV
			Percent			Percent			Percent
Inches of egg galleries	8.3	1.74	20.96	6.0	0.71	11.83	4.6	0.47	10.22
Larval galleries	27.1	7.26	26.78	11.4	2.10	18.42	11.9	1.82	15.29
Pupal chambers	15.9	3.88	24.40	3.0	.72	24.00	1.1	.05	4.55
New adults	3.8	-	-	2.2	-	-	.6	-	-

Within the larval gallery stage, the number of galleries per 3-attack density differed from numbers in the 9- and 18-attack densities, but the 9- and 18-attack densities did not differ from each other. In each of the other stages a significant difference was shown between attack densities for the number of pupal chambers, new adults, and inches of egg galleries. It is important to note that replications at each attack level showed no difference. This strengthens evidence that the difference in populations resulted from competition.

Even though the number of larval galleries was greater in the 3-attack density, the number of larval galleries per inch of egg gallery was not significantly different between attack densities (table 2). Thus, there was no apparent difference in egg hatch nor probably in fecundity of the female parent.

Table 2.--Population by stage per inch of egg gallery by attack density

Stage/inch	Attack density 3	9	18
Larval galleries/inch	3.28	1.89	2.58
Pupal chambers/inch	1.92	.50	.24
New adults/inch	.46	.37	.14

Table 3 emphasizes the gross mortality between stages and for the study. The amount of mortality due to the increased attack density occurred in direct proportion to the attack density. However, this does not necessarily mean a decrease in adult populations as can be seen in the ratio line of the table.

Table 3.--Percent mortality between stages and ratio of parent adults to new adults

Factor	Stage	3	9	18
Percent mortality	larval to pupal	41.5	73.6	90.8
	pupal to adult	76.2	25.9	41.2
	larval to adult	86.1	90.4	94.6
Ratio	parent to new	1:1.9	1:1.1	1:0.3

DISCUSSION AND SUMMARY

The experiment was designed to remove mites that are recorded as predators on eggs, provide a favorable temperature and humidity (using an environmental chamber), and vary attack density in order to assess the role of competition in the population dynamics of mountain pine beetle.

Three attack densities were used: 3, 9, and 18 per square foot, and were replicated three times. On the basis of the number of larval galleries per inch of egg galleries, it was apparent that within each attack density the larval population started out fairly uniformly. Thus, the more inches of egg galleries per square foot would result in more larvae per square foot and greater competition for food.

However, competition did affect the length of the egg galleries, lessening the average length 8.3, 6.0, and 4.6 inches per attack for the 3, 9, and 18 attack densities, respectively. Gross mortality occurred in a reverse order, as expected: 3 attacks--86.1 percent; 9--90.4 percent; and 18--94.6 percent. The most interesting result of the experiment was the ratio of parent adults to new adults. Based on two parent beetles per attack for all replicates, 18 parents (3-attack density) produced 34 new adults; 54 (9-attack density) produced 60, and 108 (18-attack density) 35. The ratios then were 1:1.9, 1:1.1, and 1:0.3, respectively.

Thus, under these laboratory controlled conditions, a population resulting from nine attacks per square foot can be expected to maintain itself in spite of a 90-percent reduction between early larval and adult stages. More than nine attacks, and the adult population should decrease. Thus, the effect of competition increases as an important factor of reduction. Fewer than nine attacks, and competition wanes in importance and a reduction in populations must depend on additional factors. On the other hand, inhibiting factors affecting young larvae in natural populations could conceivably reduce the brood rising from an 18-attack density to a point that competition was not important.

Additional studies are planned to determine the results of attack densities at closer intervals between the extremes used in this test.